U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 202.

Experiment Station Work,

XXVI.

Compiled from the Publications of the Agricultural Experiment Stations.

RECLAMATION OF FLOOD-DAMAGED LANDS.
MULCHING VEGETABLES AND FRUITS.
THE CULTIVATION OF ORCHARDS.
THINNING APPLES.
POP CORN.
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COST OF RAISING CALVES AND PIGS.
MANUFACTURE OF SAGE CHEESE.
MANUFACTURE OF COTTAGE CHEESE.
A CHEAP FRUIT EVAPORATOR.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.

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EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.[a]

RECLAMATION OF FLOOD-DAMAGED LANDS.[b]

The damage caused by the disastrous floods during the spring of 1903 in the West and methods of reclaiming flood-damaged lands is the subject of a recent bulletin of the Kansas Experiment Station, which is of practical value for all regions subject to such injury. It is estimated that these floods damaged property to the extent of $40,000,000. Not only were crops destroyed, farm products and buildings damaged, and fences, etc., washed away, but many fields were permanently injured by the washing away of the soil or by deposits of sand from a few inches to several feet in depth. Over large areas also which were covered with backwater or where the current was slight there were left deposits of mud, but aside from making more certain the destruction of the crops and perhaps throwing the fields out of use for the season, such deposits are likely in the end to prove beneficial to the land by increasing the fertility and improving the physical condition of the soil. On low lands and poorly drained fields the soil in many cases was drowned out by stagnant water, a condition which is likely to affect the productiveness of such soils for several years, even after they have been thoroughly drained.

As regards methods of reclaiming such flood-damaged lands, Prof. A. M. Ten Eyck of the station makes in substance the following suggestions:

Where a thick mud covering has been made the land should be plowed deeply, so as to mix the old soil with the new and bring some of the old soil up to the surface.

Drowned out land should be thoroughly drained at once. As soon as the surface is in fit condition disk or plow shallow; later, when the land has become drier, plow deep and leave the soil loose and mellow for a time. If the plowing is done in the fall or winter grass may be seeded the next spring; otherwise it will be better to plow as soon as

[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Kansas Sta. Bul. 121.

the soil is in a fit condition in the spring, leave the land fallow during the summer, harrow occasionally, and seed to grass early in September. If the land is fairly well drained and not too low, a mixture of orchard-grass, 10 pounds, meadow fescue, 8 pounds, *Bromus inermis*, 6 pounds, with 1 or 2 pounds of red clover per acre, will make a good pasture. For hay, sow three times the quantity named of one of the above grasses, with 2 pounds of red clover. A mixture of orchard-grass, *Bromus inermis*, and red clover will often make an excellent hay meadow. On low, wet lands a mixture of redtop, 15 pounds, and alsike clover, 2 pounds, per acre, will make a good meadow or pasture. Alsike clover may also be properly substituted for red clover with the other grasses on the drier land, and a small amount of *Bromus inermis* and perhaps orchard-grass mixed with the redtop may often prove valuable, especially for pasture, when seeded on the wetter lands.

Where the surface soil has been largely removed but no great amount of deep washing has occurred, the land may perhaps soonest be reclaimed and made productive by seeding to legumes and grasses. The soil should not be tilled deep, but shallow plowing or even disking the surface will prepare a more suitable seed bed than deep plowing. The grasses mentioned above as being adapted to fairly well-drained soils, and perhaps alfalfa, can be successfully seeded on washed lands which contain enough available plant food to start and establish the young plants. If the washed land is too poor to start grasses, or if it is desired to continue the use of the land for cultivated crops, it will be necessary to build up the humus of the soil by the application of stable manure, by green manuring, or by the growing of annual leguminous crops.

The sanded lands are perhaps the hardest to reclaim. Where the coating of sand does not exceed 2 or 3 inches cultivation during the season mixes the sand with the good soil and little trouble is likely to result. Deep plowing on such fields will more thoroughly mix the sand with the soil and give a more uniform texture and better tilth. The problem is more difficult when the covering is 6 inches to several feet in depth. When the sand is not more than 6 or 8 inches deep, it may be possible to turn it under and bring up the good soil by plowing very deep. It may be profitable, on valuable land and on small fields, to use the spade with the plow, and by digging trenches, bury the sand, and bring the good soil to the surface. In some instances where the sand lies in deep drifts it may be practicable to haul it off the field with scrapers or pile it up in large mounds.

The effect which the sand may have on the texture of the soil will depend upon the character of the soil and the coarseness of the sand. If the original soil was heavy and compact, a light dressing of sand may improve the texture and increase the available fertility, but if

the soil was already sandy, the addition of more sand will tend to reduce the fertility and produce a coarser and more open texture, unfavorable to the holding of soil moisture and to the root growth of plants.

To improve the physical condition of the soil and prepare a proper seed bed, such fields should be thoroughly firmed and packed, but even with thorough preparation lands in which the sand has been buried or mixed with the soil by deep tillage are not in a condition to seed at once to grass, but had better be planted with corn or other cultivated crops for a few seasons, or green manuring may be profitably employed, especially if the soil is light, and lacking in humus. When land has been plowed very deep and the subsoil has been brought to the surface, the land is not likely to produce well the first season, because the raw soil must weather and the bacterial growth must be reestablished before a sufficient supply of plant food can be made available to meet the requirements of the crop.

Perhaps the greatest permanent injury resulting from floods is due to the washing away of the soil, and the greatest damage in this respect is done to cultivated fields, while lands in grass or similar crops are less subject to damage by washing. For this reason it is recommended that a large part of the low-lying land bordering the streams and in the bends might profitably be kept in grasses or alfalfa much of the time, thus insuring protection to the soil in case of floods.

For lands which are too deeply covered with sand to be successfully handled in an agricultural way it is recommended that they be reclaimed by means of sand-binding grasses or by the planting of forest trees. Among the sand-binding grasses considered best suited to this purpose are beach grass or marram grass (*Ammophila arenaria*) and Canada blue grass (*Poa compressa*).

In connection with the grasses it is desirable as soon as possible to start leguminous plants of species which will endure unfavorable conditions. The sanded lands being notably deficient in humus at the surface and consequently in compounds of nitrogen, so essential as plant food, it is especially desirable to introduce those plants which are known to be nitrogen gatherers. Neither alfalfa nor the common clovers will make a "catch" in very loose, sandy ground. The sand vetch (*Vicia villosa*) is a biennial legume which does well on poor, sandy soils, forms a cover of thick matted stems a foot or so high, and self-seeds liberally. It is recommended that this vetch be sown in the spring, mixed with rye at the rate of 1 bushel to the acre. If the vetch and rye mixture be started first it may then be possible to sow Canada blue grass broadcast in the fall.

Among the trees suggested for planting on sanded areas are the catalpa, black locust, Osage orange, Russian mulberry, cottonwoods,

and the Carolina poplar, which are hardy and quick growing and will make a considerable return in a few years in form of posts or low-grade lumber.

MULCHING VEGETABLES AND FRUITS.[a]

The term mulch as generally used means a layer of litter applied to the surface of the ground primarily for the purpose of retarding evaporation from the soil. Mulches are thus used as a substitute for cultivation to conserve the moisture in the soil in summer and to keep down weeds. They are also used as winter and spring coverings for low-growing small fruits to retard flowering and fruiting and thus to protect them from injury by late frosts. What is termed a "soil mulch" or "dust mulch" is maintained by frequent cultivation of the surface soil, and, like the ordinary mulch, is an effective means of retarding evaporation. Among the common materials used for mulching crops are straw, marsh hay, and leaves. These materials are usually applied to the whole surface of the soil in layers 4 to 6 inches deep. Mulching crops with straw or other litter is not very common. On a large scale it is too expensive. It frequently happens on a farm, however, that spring finds an old straw stack in the barnyard that will be practically valueless for feed the following winter. Can it be used profitably as a mulch?

This question was investigated quite thoroughly by Prof. R. A. Emerson at the Nebraska Station. His experiments were made to determine how mulching vegetables compares with the most thorough cultivation as a general farm practice. Old straw was the material used. After settling, the layer applied was about 4 inches deep. A large number of different vegetables were grown. In general it was found that mulching in Nebraska gave much better results in normal or dry seasons than in wet seasons.

The value of the mulch in conserving the soil moisture was found to be quite marked. Soil samples taken one season in July and August showed the moisture content to a depth of 6 inches to be 18.2 per cent, as compared with 17.1 per cent in cultivated soil. When the mulch was applied early in the season before the ground became thoroughly wet, it often had a retarding effect on the growth of the vegetables. With early spring vegetables, like lettuce, which require only a few cultivations, it was found cheaper and better to cultivate than to mulch; but with longer-growing crops that require frequent cultivation throughout the season, such as cabbage, tomatoes, etc., mulching usually proved more effective and cheaper than cultivation.

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[a] Compiled from Georgia Sta. Bul. 29; Michigan Sta. Bul. 95; Nebraska Sta. Bul. 80; New Jersey Stas. Rpt. 1901, p. 388; New York Cornell Sta. Bul. 59; Ohio Sta. Bul. 137; Oklahoma Sta. Bul. 15; Wisconsin Sta. Bul. 87.

The fact that most vegetables, especially the more tender kinds, can not be mulched until they have become well established and the weather has become warm, thus requiring some preliminary cultivation, certainly increases the labor required in growing mulched vegetables over what would be necessary if the mulch could be applied earlier. But, if the impracticability of early mulching is a serious drawback to the use of mulches, so is the impracticability of midsummer cultivation under farm conditions a serious objection to dependence upon cultivation alone. For most vegetables mulching should be used to supplement cultivation rather than to displace it. Such cultivation as is commonly given farm gardens is better for most vegetables in early spring than mulching; but mulching is just as surely better in midsummer than the neglect which is the common thing in farm gardens at that time of year. The experiment station tests have indeed shown mulching to be better in many cases than the most thorough cultivation throughout the summer.

The station tests indicate that it is unwise to mulch drilled onions, lettuce, or sweet corn. The stand of the onions and lettuce is injured by mulching, while so few cultivations are required for sweet corn that mulching is hardly profitable, and in wet seasons the yield was decidedly decreased by mulching. With transplanted onions, beets, salsify, parsley, peas, and melons the labor required and yield obtained were found to be about the same by either method of culture.

With cabbage, tomatoes, beans, cucumbers, potatoes, and sweet potatoes, very favorable results were secured by mulching. The yields of each of these crops were considerably increased by mulching and the labor required was considerably less than in case of cultivation alone.

Mulched cabbage produced larger heads than cultivated cabbage, and there was less injury from rot. The vigor of tomato plants was decreased by mulching, but the yield of fruit increased. The fruit was also cleaner and less subject to rot. Mulched cucumbers produced perfect fruits during dry periods when the fruit from the cultivated plants was small and imperfect. The quality of potatoes was not hurt by mulching except in wet places.

In a special test of a 4-inch and 8-inch straw mulch and early and late mulching for potatoes a 4-inch mulch applied late in summer after several cultivations gave the best results. In the case of sweet potatoes the vines did not take root through the straw mulch as they do on cultivated ground, which was considered a decided advantage for mulching.

On the whole this work seems to indicate that on the farm where cultivation of the garden is likely to be neglected in midsummer, a mulch of straw can be used profitably as a substitute. For the best results the mulch should not be applied until the ground has become thoroughly warmed up and after two or three cultivations have been given. The mulch may then be safely applied to such vegetables as cabbage, tomatoes, potatoes, and beans, and the garden left to take care of itself the rest of the season.

Professor Halsted, working along the above lines at the New Jersey stations, one season found that mulching increased the yield of sound

fruits of eggplants 66.5 per cent and of tomatoes and peppers about 13 per cent each. The keeping quality of cucumbers also appeared to be slightly benefited by the use of a mulch. The season following, which was considerably more rainy, no advantage resulted from mulching. In this experiment there was no noticeable difference in the effectiveness of new salt hay, old hay, or excelsior as a mulch.

Several of the experiment stations have carried out experiments in mulching potatoes. The favorable results obtained in such experiments in dry seasons at the Nebraska Station have already been referred to. At the Michigan Station the following yields were obtained: Mulched, 167 bushels of potatoes per acre; cultivated, 199 bushels per acre. With another variety the yield of mulched potatoes was 252 bushels, and of cultivated, 385 bushels. The cost of cultivation was less than the cost of mulching, and the profit in both instances was in favor of cultivation. It should be stated, however, that there was a large amount of rain during this season, and that the straw used as a mulch contained a considerable amount of grain, which came up on the mulched plats, both of which conditions were unfavorable to mulching.

At the Oklahoma Station the total potato crop was increased about 50 per cent by mulching, the marketable crop nearly 100 per cent, and the size of the tubers about 70 per cent. Mulching potatoes with old shavings at the New Jersey stations increased the total number of tubers on a small plat about 16 per cent and the weight of the crop about 35 per cent. At the Georgia Station mulching potatoes with pine straw was not found to be of sufficient value to recommend the practice. These conflicting results secured with potatoes would seem to confirm the conclusion reached at the Nebraska Station that mulching is of greatest value in a dry season.

Fruit trees are sometimes mulched. At the Wisconsin Station Professor Goff made a comparison during a period of three years of the value of mulching plums as compared with cultivation. He applied a mulch of marsh hay 6 inches deep to a plum orchard in grass. The mulch was put on in winter after the ground had been packed by rain. The sod was completely killed by the mulch, except where there was quack grass. Benefits from the mulch were shown in more healthy foliage and an increase in the size and quality of the fruit produced. The advantages claimed for this sort of mulch are that it saves the labor of cultivation; prevents damage to trees caused by cultivation; makes a clean cover for the ground, which is so desirable at picking time; and adds fertilizing material to the soil as it decays. If kept 4 inches deep it prevents the growth of weeds. Its chief advantage, however, is in the superior quality and size of the fruit grown. The strongest objection to its use seems to be its tendency to induce the

roots to grow almost on top of the ground, which makes them much more easily affected by cold in severe winters.

There is, however, a drawback to mulching that may not at first occur to the reader, viz, the danger it involves from fire. In dry weather a lighted match or cigar dropped upon the mulch may easily start a conflagration that it may be impossible to stop until the orchard is destroyed. It gives disaffected trespassers in the orchard an excellent opportunity to take vengeance upon the owner.

As regards the selecting and cost of mulching material Professor Goff says:

The cost of the mulch will of course depend much upon the price at which the material may be obtained. Clean wheat, rye, or oats straw would answer the purpose well, and in many localities would be cheaper than marsh hay. In some seasons oats sown as a second crop would grow fast enough to make mulching material by the time of frost. In the vicinity of marshes the coarser marsh grasses that have no value as hay may be cut after the ground freezes in autumn and would make excellent material for mulching. Cornstalks have been suggested, but they are probably too coarse to keep down weeds.

It has been suggested that by sowing rye in September, and harvesting the crop the following June, and then sowing the same ground to millet, the rye straw with the millet would mulch an area of plums equal to that on which the two crops were grown, and would leave the thrashed rye to compensate for the labor. This is certainly worth trying by those who have no better source from which to obtain mulching.

The Ohio Station has called attention to a method of mulching orchards known as the grass-mulch method, which has been successfully used, especially on hilly land, by practical orchardists in Ohio. In this method the trees are planted in sod land, large holes being dug to receive them, and the newly planted trees are mulched with any suitable material which may be available until they are well established. When this result has been secured the orchard is mulched from year to year by simply cutting the grass and allowing it to lie where it falls. It is claimed that "all the results which are supposed to come from good tillage and cover crops" have been secured by this method. It seems under certain conditions to be a very effective means of conserving moisture and increasing the stock of humus in the soil, which are prime objects of orchard management. The Ohio Station is making a careful test of the method.

Probably the most extensive use of mulches has been in connection with the culture of small fruits. In this case mulches not only serve the usual purposes for which they are used, but, as is well known, are valuable for keeping low-growing fruits like strawberries clean and free from grit, and when applied in winter, as Professor Bailey, of the New York Cornell Station, has shown, they tend to retard spring growth and thus protect against injury by late frosts. It has been shown, for example, that "strawberry growers are able to delay the ripening of fruit, by mulching, from two days to two weeks; but a week's delay

is usually about the limit of profitable results." In order that mulching may be effective for this purpose, it is necessary that—

The top of the plant, as well as the soil, must be mulched, and in practice this is possible only with strawberries and other very low plants, or those which are laid down during winter. There is danger of injuring plants by heavy mulch which is allowed to remain late in spring. If it is desired to retard flowers or fruit by mulching, the practice should not be violent and the plants should be carefully watched.

From what has been said we may safely conclude that mulching as ordinarily practiced is an effective means of conserving soil moisture, and for this reason is likely to be of most value for dry seasons or dry regions and for long season crops. It has been shown, however, that frequent cultivation to maintain a soil mulch is a very effective and satisfactory means of conserving soil moisture, especially for orchards in dry regions. While the method of mulching with litter has many advantages and may be made to serve a very useful purpose, it also has some obvious disadvantages and must be practiced with care and discrimination. It can not be expected as a general practice to replace cultivation entirely, although it may in many cases be a valuable supplement to it and may be of great advantage in lessening the amount of cultivation required at a season of the year (midsummer) when the pressure of farm work may be so great as to render thorough tillage of garden and orchard difficult or impracticable.

THE CULTIVATION OF ORCHARDS.[a]

Though the culture of orchards is often neglected, the benefit which may be derived from it in some form (clean cultivation, culture of cover and other crops, etc.), is widely recognized, and the practice is receiving increasing attention from year to year, especially in regions of dry summers and cold winters. It is becoming more generally understood that under such conditions the system of culture has a decided influence, especially on the conservation of moisture during drought and on the ripening of the wood of trees in the fall so that they can withstand the winter cold.

Professor Emerson of the Nebraska Station has carried on a series of experiments with apples, cherries, peaches, pears, and plums, extending over several years, to determine as definitely as possible the relation of clean cultivation and various systems of cropping (cover crops, vegetables, corn, oats, etc.) and mulching to the moisture content of the soil and the growth of the trees, to winterkilling, and to root injury.

The clean cultivation consisted of disking at least once in two weeks from March to October and harrowing as soon as possible after each rain to preserve a dust mulch. Where ordinary cultivated crops were grown they received the usual cultivation, being kept free from weeds.

[a] Compiled from Nebraska Sta. Bul. 79.

The cover crops—oats, millet, and weeds—were allowed to remain on the ground during the winter and were worked into the soil the following spring.

The influence of the different methods of culture on the drought-killing of young trees is shown in the following diagram:

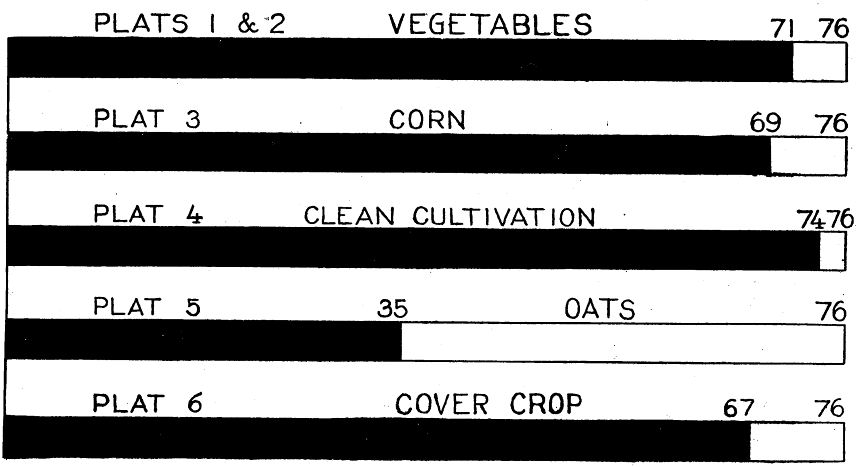

FIG. 1.—The influence of different methods of culture on the drought-killing of young trees. The shaded parts represent the number of live trees, the unshaded parts the number of dead trees at the end of the first year.

The effect of the methods of culture on the growth of the trees is shown in the following diagrams:

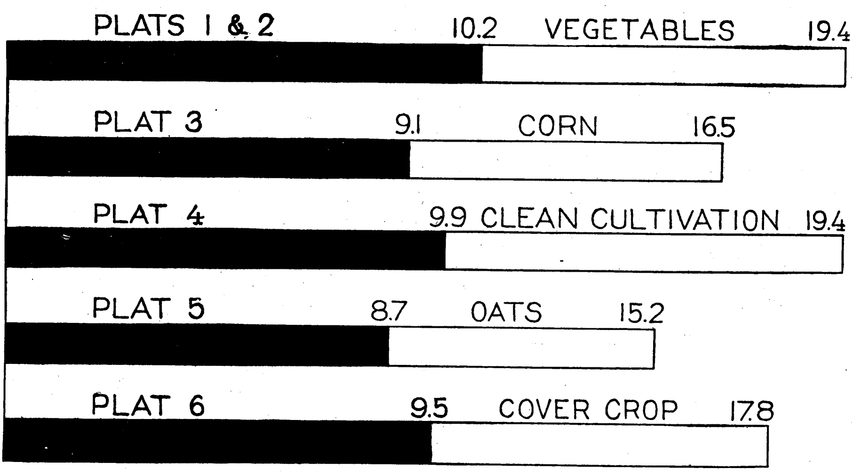

FIG. 2.—Diameters of trees (in sixteenths of an inch) at the end of the first year (shaded part) and second year (full length of bar).

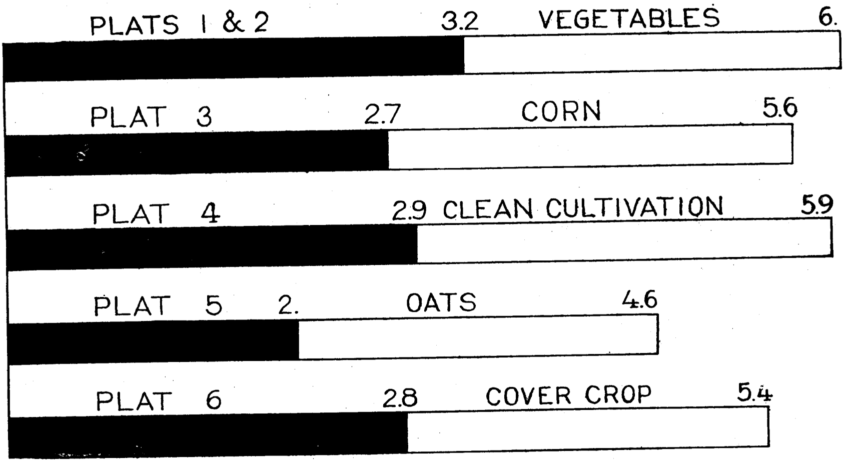

FIG. 3.—Height in feet of trees (full length of bars) and spread of branches (shaded part) at the end of second year.

The effect of cover crops on winterkilling was tested during 1901 and 1902 on 48 peach trees of the Wager variety, set for the purpose in two blocks, one on moderately rich upland loam soil with northern exposure and the other on rich, well-drained bottom land protected on all sides by wind-breaks. Both blocks received clean culture until midsummer, when each block was divided into 3 plats of 8 trees each.

In one plat of each block oats was sown as a cover crop and in a second plat millet was similarly sown. * * * The trees in the upland block stopped growing early in fall and their wood matured well before cold weather. No great difference was noticed between the trees that were cultivated and those in the cover-crop plats. In the block of trees on the bottom land, however, striking differences were seen between the different plats. The trees in the cover-crop plats practically stopped growing by the middle of August, only a month after the cover crops were sown, and began to

FIG. 4.—Mature (*a*) and immature (*b*) peach twigs.

mature their wood. The trees in the plat given late cultivation continued growth much later. The cultivated trees had matured their wood and formed their terminal buds no more perfectly by the middle of October than the cover-crop trees had by the middle of August. By the first or middle of November, 1901, little difference could be seen between the trees of the cultivated plat and those in the cover crops, so far as maturity of the season's growth of wood was concerned. The wood of all trees seemed well ripened and ready for winter. The trees of the cultivated plat were considerably larger, as a whole, than those of the oats and millet plats.

The effect of late cultivation and cover crops on winterkilling is shown in the following diagram:

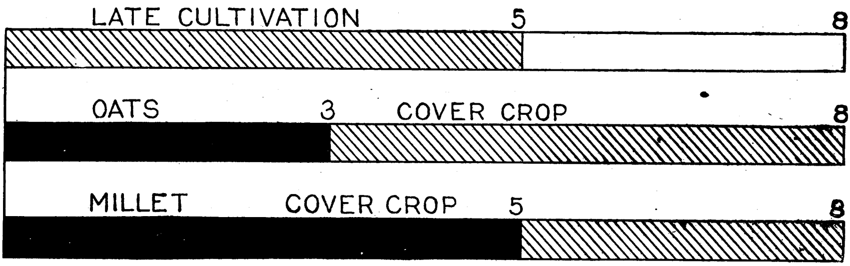

FIG. 5.—Relation of late cultivation and cover crops to winterkilling of young peach trees. Dead trees represented by unshaded parts, badly injured by lightly shaded parts, uninjured by heavily shaded parts.

The relation of soil moisture and soil cover to root killing of apple and cherry stocks was studied in a series of box experiments. The results showed that a straw mulch, or a cover crop that mats down like a straw mulch, tends to prevent freezing and alternate freezing and thawing, and thus reduces injury to the roots.

Any method of culture that leaves the ground perfectly bare in fall, thus favoring deep freezing and alternate freezing and thawing, is not to be recommended where root killing is at all common. A cover crop is one of the best means of protecting the roots of trees. Likewise, any method of culture that leaves the ground moist in fall has an advantage over methods that leave the ground very dry. In this regard, clean cultivation might be expected to be ahead of cover crops. As a matter of fact, however, during the three years that cover-crop experiments have been carried on at the experiment station, the soil under cover crops that are killed by the early frosts has been as moist on the approach of cold weather as ground given clean cultivation throughout the fall.

In conclusion, the author states that the results of the experiments on orchard culture as a whole indicate that—

The best all-around method of culture for young orchards is thorough cultivation in early summer, followed by a cover crop in fall, so far as tests covering only a few years can prove any method best. A mulch of straw is known to keep the soil moist during summer, and it also protects tender roots in winter, but its use will surely increase winter injury to tender tops of trees by prolonging fall growth. Besides, a mulch induces shallow root development, which may result disastrously in later years, and its use is out of the question in large orchards. Thorough cultivation protects trees against drought as well as mulching, and keeps the roots from forming near the surface of the ground. When cultivation is given in early summer all that is necessary in order to furnish winter protection is to stop cultivating in midsummer, grow a cover crop (weeds being better than nothing) which will dry

the ground in fall, causing the new wood growth to ripen early in preparation for winter, and which will, by holding the snow or by matting down to form a mulch, protect tender roots during winter. Good cultivation in early summer can often be given young trees by growing some cultivated crop in the orchard. Tender crops are best, since they can not be sown so early as to dry the ground seriously in spring, and are killed by fall frosts, thus preventing very late drying. Cropping with corn, for instance, insures fairly thorough early cultivation, and corn is a fair substitute for a cover crop in fall and winter.

THINNING APPLES.[a]

In an earlier number of this series of bulletins[b] the results secured at the Massachusetts Hatch and New York State stations in thinning apples were reported. The work at the New York State Station with this fruit was continued, and Professor Beach has made a final report on the subject. The plan of the experiment was to study the value of thinning the fruit of apple trees in a commercial orchard which was well cared for as regards culture, manuring, and spraying. It was proposed to find out how thinning would influence quantity, size, quality, and market value of the fruit; and also what effect thinning would have in inducing trees to bear regular yearly crops instead of large crops in alternate years. Three methods of thinning were observed. In every case all wormy, knotty, or otherwise undesirable fruits were first removed, and then by the first method each cluster was thinned to one fruit. By the second method the fruits were thinned to 4 inches apart, and by the third to 6 inches apart. The conclusions reached by Professor Beach as the result of four years' experiments along the above lines with Baldwin, Rhode Island Greening, and Hubbardston Nonesuch are as follows:

When the trees were well filled with fruits thinning generally improved the color. At harvest time the various hues were heightened and tended to be more brilliant on fruit from thinned than from corresponding unthinned trees. Where the fruit set sparsely before it was thinned, the thinning had no appreciable influence on its color.

Whenever the trees bore well thinning had the effect of increasing the size of the fruit. This occurred with Baldwin and Hubbardston more often than with Greening, which may be accounted for by the fact that the Greening trees did not carry any crops so heavy as the heaviest crops of Hubbardston and of Baldwin.

The intrinsic value of the apples from the consumer's standpoint was generally increased by thinning, the thinned fruit being usually superior in size, color, and general quality. The thinned fruit, as a rule, was better adapted than the unthinned for making fancy grades, for marketing in boxes, etc. Where such ways of marketing can be advantageously used, the thinned fruit should bring an increase in price corresponding to its superiority in real value. But where it must be put upon the ordinary market in barrels there is less chance for the thinned fruit to sell at sufficient advance over the unthinned to pay for thinning, especially if the thinned fruit can not be furnished in large quantities.

[a] Compiled from New York State Sta. Bul. 239; Connecticut Storrs Sta. Rpt. 1902-3, p. 28.

[b] U. S. Dept. of Agr., Farmers' Bul. 73, p. 15.

In these experiments the practice of thinning the fruit did not appear to cause any material change in either the amount or the regularity of fruit production.

The amount of thinning to do will depend entirely upon the condition and age of the tree and the quantity of fruit that is set.

In thinning apples all wormy and otherwise inferior specimens should first be removed and no more than one fruit from each cluster should be allowed to remain. After this is done, if there is a full set of fruit, greater improvement in the grade may be expected from thinning to 6 inches than to 4 inches apart.

In discussing the question as to whether or not it will pay to thin apples, the opinion of a practical fruit grower, in whose orchard the experiment was conducted, is quoted, to the effect that when there is a general crop of apples and the crop set is very full, so that the chances for small fruit is very great and widespread over the country, it will pay to thin to such an extent as to insure good-sized fruit; otherwise it will not pay, except as a protection to the tree.

It is advised that thinning begin within three or four weeks after the fruit sets, even if the June drop is not completed. The cost of thinning, it is believed, should not exceed 50 cents per tree.

In experiments by the Connecticut Storrs Station in thinning apples one season on two Baldwin trees, the first-grade thinned apples were slightly larger than the first-grade unthinned, and the increased value of the fruit due to thinning was 77½ cents on one tree and $1.83 on the other. Attention is called to the desirability of removing all discarded fruit from the orchard and either burning or burying it, "as these fruits contain many partly developed codling-moth larvæ, curculio, and other insects. Discarded peaches and plums, if left under the trees, furnish a medium for the development of rots."

POP CORN.[a]

In earlier times pop corn was very commonly grown in small quantities on many farms and in gardens for home consumption for it has long been a favorite food or food accessory with Americans. In recent years there has been a tendency to depend on the larger growers for pop corn and this crop is now raised in some regions to a very large extent. For instance, a large grower in Iowa is reported to have 1,000 acres annually planted to pop corn and in some regions of Nebraska, notably on the north and middle Loups, pop corn is practically the only crop grown, 100 bushels to the acre, it is said, being

[a] Colorado Sta. Rpt. 1884, p. 89; Illinois Sta. Bul. 13; Nebraska Sta. Buls. 12, 19; New York Cornell Sta. Bul. 16; New York State Sta. Rpt. 1883, p. 50; New York State Sta. Rpt. 1884, p. 183; Vermont Sta. Rpt. 1889, p. 134; Maine Sta., unpublished data.

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an ordinary yield. Fine pop corn is also grown on a large scale in some regions of Michigan.

E. L. Sturtevant[a] describes 25 varieties of pop corn which are divided into three groups, the first containing varieties having kernels broader than deep, the second those having kernels as broad as deep, and the third those having kernels deeper than broad. As examples may be mentioned Nonpareil, which belongs to the first group; Small Pearl, Dwarf Golden or Tom Thumb, belonging to the second, and Queen's Golden, and the various rice corns to the third.

Numerous tests of varieties of pop corn have been made by the Colorado, Nebraska, New York Cornell, New York State, and Vermont experiment stations.

As regards the culture of pop corn it may be said in brief that it is much the same as for sweet corn. When grown on a large scale it is drilled in and is not planted in checks. It is usually harvested by hand and marketed on the cob or shelled. It is difficult to estimate the cost of production owing to the limited data available, but according to a Nebraska writer it can probably be grown and put on the market for $12 to $15 an acre. Several years ago pop corn sold in Nebraska for $1.50 per 100 pounds, but for last year's crop (1903) only 90 cents per 100 pounds was offered. Assuming that the yield is 80 bushels to the acre, the latter price would give a return of something like $25 to the acre. A prominent Iowa grower of pop corn states that in his experience the price has been as low as 50 cents and as high as $4 per 100 pounds.

The chemical composition of pop corn, raw and popped, was studied some years ago by W. H. Brewer.[b] In recent investigations carried on at the Maine Experiment Station, the results of which are not yet published, pop corn, yellow field corn, and sweet corn were analyzed before and after popping. In every case the corn was popped in a corn popper over a medium hot coal fire, care being taken to have the experimental conditions uniform. The pop corn popped thoroughly and completely; the field corn popped, but the expansion of the kernels was much less than was the case with pop corn, and the sweet corn parched rather than popped, the kernels doubling in size, but not having the characteristic appearance of pop corn.

The following table summarizes the data regarding the composition of popped and unpopped corn, the results being expressed both on a fresh and water-free basis:

[a] U. S. Dept. Agr., Office of Experiment Stations Bul. 57.

[b] Tenth Census United States, Census Rpt. 1880, vol. 3 (Agriculture), p. 418.

Composition of corn before and after popping.

Kind of corn.	Fresh material. Water.	Fresh material. Protein.	Fresh material. Fat.	Fresh material. Nitrogen-free extract.	Fresh material. Crude fiber.	Fresh material. Ash.	Water-free material. Protein.	Water-free material. Fat.	Water-free material. Nitrogen-free extract.	Water-free material. Crude fiber.	Water-free material. Ash.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Pop corn, white and yellow varieties, raw[a]	12.6	10.3	4.2	70.4	1.2	1.3	11.8	4.8	80.6	1.3	1.5
Pop corn, white and yellow varieties, popped[a]	4.1	11.1	4.7	77.3	1.4	1.4	11.5	4.9	80.6	1.5	1.5
Pop corn, raw[b]	10.1	12.1	4.7	69.3	2.2	1.6	13.5	5.2	77.1	2.4	1.8
Pop corn, popped[b]	3.6	12.9	5.5	73.6	2.5	1.9	13.3	5.7	76.4	2.6	2.0
Field corn, Yellow Canada, raw[b]	9.6	10.6	5.1	71.5	1.6	1.6	11.7	5.6	79.1	1.8	1.8
Field corn, Yellow Canada, popped[b]	5.5	11.1	5.3	74.7	1.7	1.7	11.8	5.6	79.1	1.8	1.7
Sweet corn, White Corey, raw[b]	9.5	11.8	5.2	69.7	2.1	1.7	13.0	5.8	77.0	2.3	1.9
Sweet corn, White Corey, parched[b]	3.9	12.8	7.2	71.9	2.5	1.7	13.3	7.5	74.8	2.6	1.8

[a] Tenth Census United States, Census Rpt. 1880, vol. 3 (Agriculture), p. 418.
[b] Maine Sta., unpublished data.

As will be noted, the principal change in composition brought about by popping was a considerable loss of water due to the evaporation of moisture by the heat employed.

There is always a loss of weight in popping corn, as might be expected from the fact that so much moisture is driven off. In some experiments carried on by M. I. Wilbert[a] 100 grains of unpopped pop corn weighed 13 grams. The same quantity partially popped weighed 11 grams; fully popped, 9.2 grams; and carefully dried and parched without popping, 7.5 grams, the loss in weight being 15.4, 29.2, and 42.3 per cent, respectively. In the experiments of the Maine Station the pop corn lost in popping 9.2 per cent in weight, the field corn 10.3 per cent, and the sweet corn 8.6 per cent on an average.

An explanation of the popping of corn is furnished by results recently published by Wilbert,[b] whose observation and experiment led to the conclusion that the great enlargement of the kernel and change in form and texture is caused by an expansion of moisture in the starch cells. Each individual cell is a miniature sealed bomb, the walls of which are sufficiently dense to retain the moisture until it has been converted into steam under pressure.

If the residual moisture is sufficient and the conversion into steam is uniform and rapid, the greater number of cells of which the kernel is composed will be exploded and the result will be a large, dry, mealy mass of converted cornstarch. If the corn is old and dry it will at best only split open from a number of cells near the center of the corn kernel. If the application of heat be made slowly it is possible to dry the kernels of corn, parch, and even char them without rupturing the outer coat in any way.

It was also noted that at the base of the kernels, or at the point of attachment to the cob, the cells were less compact and were seldom, if

[a] Amer. Jour. Pharm., 75 (1903), pp. 77–79. [b] Loc. cit.

ever, ruptured by the generated steam. It is from this point, too, that the kernels of corn appear to dry most rapidly. The bearing of these observations on the theory that popping is caused by an explosion of steam is found, according to Wilbert, in the fact that pop corn invariably bursts first at the densest portion of the kernel, and never at or near its base or point of attachment.

When old and dry corn was soaked for twelve hours and then dried for an equal time it did not pop well. If kernels were allowed to dry for twenty-four hours longer the resulting kernels of popped corn were found not only to be very large, light, and flaky, but had absolutely no suggestion of toughness.

FRUIT FOR FARM ANIMALS.[a]

Wherever orchard fruits, and more especially apples, are raised, it is a common custom to feed windfalls. Apple cores, parings, and similar household waste often form a part of kitchen slop or swill, which is fed to live stock or poultry. In such cases the fruit is not regarded as a very important part of the ration, although it is apparently eaten with relish. At the New Hampshire Station common cider or windfall apples, valued at 10 cents per bushel, were fed as part of the ration to pigs, but were not regarded as an economical feeding stuff. Apple pomace, which remains when cider is expressed, has been used as a feeding stuff both fresh and ensiled,[b] and in Europe the same is true of the pomace obtained in wine making and in the oil industry. The California Station has studied the composition of American olive pomace as well as fresh and dried fruits with reference to their use as feeding stuffs.

In regions like California, where fruit growing is such a large industry, the profitable utilization as stock feed of windfalls, which are generally immature and unsalable, or ripe fruit, fresh or dried, which can not be profitably sold owing to market conditions or an inferior quality, is a matter of considerable importance. It is well known that farm animals, generally speaking, will eat fresh fruits readily, and tests made by California feeders have shown that the taste for dried fruits is readily acquired, stock possibly relishing such materials on account of their sweet taste. Jaffa and Anderson, of the California Station, have shown that fresh fruits contain a large amount of water and a low percentage of nutritive material, consisting chiefly of carbohydrates (sugars, starches, etc.). Dried fruits are much richer in proportion to their bulk, having been concentrated by evaporation. For instance, fresh apples contain some 85 per cent water and 14 per cent nutrients, while dried prunes contain about

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[a] Compiled from California Sta. Bul. 132.

[b] U. S. Dept. Agr., Farmers' Bul. 186, p. 21.

25 per cent water and 70 per cent nutrients, chiefly sugar. The fresh fruits are very succulent feeds. Since the nutritive material in both fresh and dried fruits consists largely of carbohydrates they can not form a well-balanced ration, but should be combined with the concentrated feeds containing protein. The authors compared the value of fresh and dried fruits with more common feeding stuffs, rating protein at 1.7, fat at 3.31, and carbohydrates at 0.75 cents per pound. The values obtained are given in the following table, which shows the amounts of a number of common feeding stuffs equivalent to 100 pounds of fruit of different sorts.

Calculated value of fruits compared with hay, grains, etc.

One hundred pounds of each of the fruits named below is equivalent to the amounts of the materials given in the columns to the right.	Wheat straw.	Alfalfa hay.	Oat hay.	Corn.	Barley.	Oats.	Wheat.	Wheat bran.	Wheat middlings.	Rice bran.	Cotton-seed meal.
FRESH FRUITS.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Apples	34	20	24	15	15	17	16	18	16	13	9
Oranges	33	19	23	14	14	16	15	17	15	12	8
Pears	40	23	30	17	18	20	19	20	19	15	11
Plums	50	30	36	22	24	25	24	26	24	20	14
Prunes	46	27	33	20	22	23	22	24	22	18	13
Apricots	40	23	29	17	18	20	19	20	19	15	11
Nectarines	43	26	30	19	20	22	21	23	21	17	12
Figs	50	30	37	23	24	26	25	27	25	20	14
Grapes	50	30	37	23	24	26	25	27	25	20	14
Watermelons	22	13	16	10	10	11	11	12	11	8	6
Nutmeg melons	19	11	13	8	9	9	9	10	9	7	5
DRIED FRUITS.											
Prunes	175	104	125	78	82	88	84	92	84	67	48
Apricots	194	115	138	86	90	97	93	102	93	74	53
Peaches	190	113	135	85	88	95	91	100	91	72	51
Figs	186	110	132	83	85	93	89	97	89	71	50
Raisins	216	128	153	97	100	108	103	111	103	82	59

On the basis of the above comparison melons are the least valuable of the fresh fruits mentioned. For example, according to the table, 100 pounds of nutmeg melons is equivalent to only 19 pounds of wheat straw, or 5 pounds of cotton-seed meal. Apples and oranges are practically equal in food value (100 pounds being equivalent to 33–34 pounds of wheat straw), rating nearly 50 per cent higher than the melons. Prunes represent a fair average of pitted fresh fruits. The nutritive material found in grapes and fresh figs is practically the same, both ranking with pitted fruits in feeding value. As stated above, the dried fruits contain much more nutritive material in proportion to their bulk than fresh fruits. On the basis of the method of comparison followed, raisins have the highest feeding value, while dried apricots rank only a little lower.

A sow weighing 260 pounds, from which a litter of pigs had just been taken, was fed at the California Station during a preliminary feeding period on barley and dried figs, and then for nine days on all

the dried figs she would consume, which amounted on an average to 24.4 pounds per day. The average daily gain was $3\frac{1}{3}$ pounds, the figs consumed per pound of gain being, therefore, 7.3 pounds. It is pointed out that the conditions were unusually favorable for gains in weight. Rating pork at $4\frac{1}{2}$ cents per pound, live weight, the figs eaten were worth $1.35, or at the rate of $12.50 per ton. It is estimated that 200 pounds of grain would be required to produce the same gains in weight as were made on figs. This corresponds quite closely with the calculated comparative values in the table above.

It may be a difficult question, at times when prices are extremely low, to decide which would be the better economy, to feed the fruit to cattle or to receive whatever small returns might be offered for it in the market. When, however, there is no market for the fruit, there may be nothing left to be done but to feed it to stock, and the above results indicate that it may be profitably disposed of in this way. The authors believe that the best way of feeding fruit would be to use such materials to supply the carbohydrate portion (sugars, starches, etc.) of the ration and make up the deficiency of nitrogenous material (protein) with some concentrated feed, such as cotton-seed meal or other rich nitrogenous feed, thus making a complete and economic ration.

As an illustration they give the following:

A cow (1,000 pounds weight) requires per day about 25 pounds of dry matter, containing 2.5 pounds of digestible protein, 12.5 pounds of carbohydrates, and 0.40 pound of fat, with a fuel value of 30,000. If we have hays, grain, and bran, a good ration would be 12 pounds of alfalfa hay, 13 pounds of wheat hay, and 5 pounds of bran. The 5 pounds of bran could be replaced by 15 pounds of fresh prunes, and the deficiency in the protein resulting from the substitution could be made up with 1 pound of cotton-seed meal; or 5 pounds of raisins could take the place of the prunes, in which case $\frac{3}{4}$ pound of cotton-seed meal would suffice for the needed amount of protein. Either of the above changes from the conventional ration would make it complete with respect to its contents of digestible nutrients. But the objection might be raised, and with just cause, that the ration would prove very laxative. To obviate this, it would probably be best to use a less amount of fruit and mix it with bran or middlings, etc., to prevent "scouring" the animal. A little careful experimenting on the part of the feeder would soon settle the matter.

HOME-GROWN V. PURCHASED PROTEIN FOR DAIRY COWS.[a]

In a bulletin of the New Jersey stations, C. B. Lane states that "any increase in the price of feeds commonly used in the dairy naturally causes the dairyman to seek some substitute for purchased feeds which will enable him to produce milk at a less cost. There are many crops which can be grown and made into hay, as alfalfa, crimson clover, oats and peas, cowpeas and soy beans, which are rich in that

[a] Compiled from New Jersey Sta. Bul. 161; Rpt. 1902, p. 316.

important nutrient, protein, and which will in a large measure take the place of fine feeds in balancing a ration."

In order to make a practical study of the question of the economy of substituting home-grown feeds for purchased feeds as sources of protein, three feeding experiments, each of about a month's duration, were carried out with milch cows. The home-grown feeds used were alfalfa hay, crimson clover, and cowpea silage; the purchased feeds wheat bran, dried brewers' grains, and cotton-seed meal. In every case the lots compared contained two cows, and the rations were so arranged that practically the same amount of protein was supplied to each lot.

In the first test the ration of home-grown feeds, which was made up of 13 pounds of alfalfa hay and 30 pounds of corn silage, proved both practical and economical when fed in comparison with a ration in which over two-thirds of the protein was derived from wheat bran and brewers' grains. This latter ration produced 4.15 per cent more milk and 4.16 per cent more butter than the alfalfa ration, the fat content of the milk being the same in both cases. Milk was produced more cheaply on the home-grown ration, the cost being 59.9 cents per 100 pounds on the home-grown ration and 83.9 cents with the purchased feeds. The profit from feeding the home-grown ration, calculated for milk at $1 per 100 pounds, would amount to $1.99 per cow per month. On the basis of this test the author calculated that "when mixed hay (timothy and redtop) sells for $16 per ton, and wheat bran can be purchased for $26 per ton, and dried brewers' grains for $20 per ton, alfalfa hay is worth $24.52 per ton as a substitute for mixed hay, wheat bran, and dried brewers' grains, fed in the proportion indicated in the ration."

The second home-grown ration studied was made up of 16.4 pounds of crimson clover and 30 pounds of corn silage, and proved of practical value from the feeder's standpoint, since it reduced the cost of milk 18.3 cents per 100 pounds when fed in comparison with a ration in which the protein was largely supplied in the form of wheat bran and dried brewers' grains. Although 18.1 per cent more milk was produced on the purchased ration, the profit was $1.10 per cow per month greater on the home-grown ration. On the basis of this test it was calculated that with wheat bran at $26, dried brewers' grains at $20, and mixed hay (timothy and redtop) at $16 per ton, crimson clover hay is worth $16.55 per ton when fed under the experimental conditions.

In the third test a home-grown ration made up of 36 pounds of cowpea silage, and 10 pounds of crimson clover hay, with 6 pounds of corn-and-cob meal, costing 16.57 cents per cow per day, produced as much milk and butter as a ration in which two-thirds of the protein

was supplied by dried brewers' grains and cotton-seed meal, costing 17.15 cents.

The results of this experiment are significant in showing that a ration composed of home-grown crops, though costing nearly as much (when the crops are figured at the market price), may be fully equal as a milk producer to a ration in which the protein is largely supplied by purchased feeds. Home-grown crops were utilized in the dairy at a greater profit than could have been realized by selling them at the market price.

It should be borne in mind, however, as the same author points out, that the purchase of concentrated feeds rich in protein may be profitable from the standpoint of the maintenance of soil fertility, for "if all the milk sold from the farm was obtained from foods grown on the farm, the exhaustion of nitrogen would be in greater proportion than the mineral elements, and, when this is the practice, it is necessary to apply nitrogenous fertilizers in order to maintain the fertility. If manure is well cared for and used properly, it is more economical to purchase the nitrogen in the form of feeding stuffs, whose whole cost is returned in the increased product resulting from the use of well-balanced rations."

COST OF RAISING CALVES AND PIGS FROM BIRTH TO MATURITY.[a]

A great many experiments in the feeding of farm animals have been made, but they have been incomplete as a basis for estimating the absolute cost and profits of animal production, because as a rule they cover only a small portion of the animal's life. Realizing the importance of more complete data in this respect, several of the experiment stations have made records of the amount and cost of food consumed by various farm animals from birth to maturity. While these observations need to be repeated many times under a variety of conditions before it would be safe to draw too positive conclusions from them, the results already obtained are suggestive and of considerable practical value.

W. Clark, of the Alabama Experiment Station, has recorded data regarding the cost of raising heifer calves. In a number of cases the record covered the period from birth to maturity—that is, for approximately two years. One of the calves weighing at birth 56 pounds, consumed during the first year 159 pounds of whole milk, 2,738 pounds of skim milk, 66 pounds bran, 224 pounds of hay, and was pastured for one hundred and sixty-one days. When one year old she had cost $12.86 and weighed 435 pounds. During the second year the ration was made up of sorghum hay, silage, oat straw, corn stover, and a little cotton seed and bran. The period on pasture covered two hundred and twenty-four days. The cost of the feed was

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[a] Compiled from Alabama College Sta. Bul. 121; Connecticut Storrs Sta. Rpt. 1902-3, p. 187; Wisconsin Sta. Bul. 104.

$9.09 and she weighed at the end of the year 665 pounds. She dropped her first calf a few days before she was two years old. The total cost of feed up to this time was $21.95.

The feed eaten by two other calves, which the author believes made a normal growth, cost $11.40 and $13.66, respectively, for the first year. One of these calves weighed 43 pounds at birth and during the first year consumed 92 pounds of whole milk, 1,192 pounds skim milk, 322 pounds hay, and 204 pounds of bran, and was on pasture one hundred and sixty-five days. The other calf weighed 50 pounds at birth and was fed in much the same way, weighing when a year old 350 pounds.

Data are also recorded regarding three other calves, which the author believes consumed too little skim milk during the first year and hence did not make satisfactory growth. Furthermore, they were accidentally bred too early. One of these calves weighed 50 pounds at birth. During the first year 260 pounds of whole milk, 1,195 pounds of skim milk, 180 pounds of bran, 63 pounds of corn meal, and 405 pounds of hay were eaten, and the calf was on pasture one hundred and twelve days. The cost of feed for the first year was $11.65 and the weight when a year old 340 pounds. Aside from pasturage she was fed during the second year cotton seed, corn stover, oat straw, and silage. She dropped her first calf when twenty-two months old. The cost of feed up to the time of calving was $7.61, making the total cost of feeding $19.26.

The second of these calves weighed 36 pounds at birth. She was fed under much the same conditions as the other, consuming 1,097 pounds of skim milk the first year, and dropped her first calf when two years old. Her weight when a year old was 350 pounds, and the total cost of feeding for two years $19.48.

The third calf weighed 38 pounds at birth, and during the first year was fed skim milk and whole milk in addition to some grain, hay, and pasturage, the amount of skim milk consumed being 1,740 pounds. The first calf was dropped when nineteen months old, and her weight was then 445 pounds. The total cost of feeding up to this time was $17.21.

Considering the test as a whole, the average cost for the first year's growth of these calves was $11.77, or from birth until the time of calving $19.47.

The same question was more recently studied by C. L. Beach, at the Connecticut Storrs Station. For several years records were kept of the cost of feed consumed by calves from birth until about six months old. In 1899 new milk was fed for some six weeks and was then replaced by skim milk. In 1900 the change in the milk ration was made when the calves were less than two weeks old. Rowen (second

cut) hay was kept before the calves at all times. No grain was fed in 1899, but in 1900 it was given during the last two months of the feeding period. The calves were designed for the dairy herd and were fed with that end in view. The ration was bulky and palatable and supplied sufficient protein and mineral matter, although it was not sufficient in amount to induce gains in body fat.

Eight calves in 1899 gained on an average 1.31 pounds per day, the cost of feed being 6.8 cents per day, and 9 calves in 1900 made an average gain of 1.25 pounds per day each, the cost of gain being 6.4 cents per day. On the basis of the recorded data the estimated cost of raising a calf until two years old is $33.20. Basing his estimate on the prevailing prices for feeding stuffs in Connecticut, the author calculates that the cost of feeding 8 calves seventeen weeks, in a test reported by the New Hampshire Station, to be 7.3 cents per day, the average gain per day being 1.35 pounds.

At the Wisconsin Experiment Station, W. L. Carlyle studied the growth made by 12 litters of pigs and the cost of gain from birth until they were large enough for slaughtering. The litters varied more or less in weight at birth and in general the gains were influenced by this factor. Each pig in the litters averaging 23.5 pounds at birth made an average gain of 4 pounds per week for the twelve weeks before weaning; those averaging 16 pounds, an average gain of 3.6 pounds per pig per week; and those averaging less than 15 pounds, an average gain of 2.9 pounds per pig per week. Considering the results as a whole, the average daily gain per pig before weaning was 0.4 pound in the first month of the test, 0.47 pound in the second, and 0.69 pound in the third. From the time they were four weeks old until weaned the pigs were given some grain. After weaning, the feeding test was continued eight weeks and they were given corn or a mixture of concentrated feeds with skim milk or meat meal. For the first month after weaning the average daily gain for a pig was 0.71 pound and for the second month 0.81 pound.

The amount of feed required per pound of gain and its cost were calculated in every case, and "the amount eaten by the sow while she was suckling the pigs is always charged to the pigs, less the sow's feed of maintenance." On this assumption a pound of gain required from 1.7 pounds grain and 6.1 pounds skim milk in the first month of the whole period, before and after weaning, to 3.9 pounds of grain and 6.2 pounds of skim milk in the last month, the cost of a pound of gain ranging from 2.21 cents to 3.96 cents.

With 2 pigs from each litter, the feeding test was continued on the same rations as before for twelve weeks, that is, until the pigs were ready for slaughter. The first four weeks of this period the average net gain per pig was 29.1 pounds and for the last four weeks it was 32.4 pounds, the cost of a pound of gain being 3.19 cents and 4.20

cents, respectively. The corresponding values for the first four weeks of the nursing period were 8.8 pounds and 1.17 cents, and for the test as a whole 22.1 pounds and 2.8 cents per month.

On the basis of the figures recorded the author calculates that on an average it requires 2.77 pounds of digestible nutrients, at a cost of 3.12 cents, to produce a pound of gain with pigs from birth to maturity, the nutritive ratio of the ration being 1:3.99.

MANUFACTURE OF SAGE CHEESE.[a]

Sage cheese, with its yellow surface mottled and flecked with small dark grayish green spots, is an old-time favorite. Sage is a very old seasoning herb and sage cheese is very probably of old English origin. The manufacture of sage cheese is now carried on in a limited way only in the United States, and is restricted to certain localities, yet a great many people are exceedingly fond of it, and will pay from one to two cents per pound more for it than for ordinary cheese.

The Michigan Experiment Station has studied the subject of sage cheese making and states that this cheese is prepared in exactly the same way as Cheddar, i. e., common American factory cheese, differing from it only in possessing a sage flavor, which is imparted to it by adding sage extract or sage tea to the milk before the curd is precipitated, by adding the extract to the curd before salting, or by adding sage leaves to the curd before salting.

The addition of sage tea or extract to the milk is objectionable, requiring a large amount of sage, 10 to 12 ounces for one thousand pounds of milk.

The addition of extract to the curd gave entirely satisfactory results in tests at the station when the extract was not too dilute, and when it was added very cautiously to prevent waste. The amount of sage required was 6 or 7 ounces for the curd from a thousand pounds of milk.

The most satisfactory method, however, was found to be the old-fashioned way of adding the sage leaves to the curd. This required the least amount of sage, 3 ounces being sufficient for the curd from a thousand pounds of milk. In following this method the sage should be weighed, the stems all picked out and the leaves finely powdered and added to the curd just before salting.

One of the important Swiss cheeses resembles sage cheese in that the powdered leaves of a plant are added in its manufacture. This "*schabziger*," green, or "*kräuter*" cheese is made from sour skim milk and buttermilk, the dried powdered leaves of rock clover (*Melilotus cœrulea*) being thoroughly mixed with the ground curd. The small grayish green cone-shaped cheeses are exported in large numbers and are a familiar sight in large markets.

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[a] Compiled from Michigan Sta. Special Bul. 21.

MANUFACTURE OF COTTAGE CHEESE.[a]

Cottage cheese, or Dutch cheese, is extensively made and consumed on farms in this country. It is also made in many factories located near cities, where there is always some demand for this product. Whole milk or skim milk is ordinarily used for this purpose, but sometimes buttermilk is employed. The milk is allowed to become sour, then heated, the whey drained off, and the remaining curd kneaded, salted, and pressed into the form of balls, when it is ready for consumption. When manufactured on a commercial scale starters are usually employed to hasten the souring of the milk, and a small amount of rennet is often added to hasten curdling. As the use of whole milk is attended by considerable loss of fat, skim milk is usually employed, and cream is sometimes added to the cheese at the time of working and salting. Cottage cheese is very palatable and nutritious, and recent experiments indicate that it is more easily digested than fresh Cheddar cheese.

In a recent bulletin of the New York State Station L. L. Van Slyke and E. B. Hart state that "the directions commonly given for the manufacture of cottage cheese vary greatly in their details as stated by different writers, but in general there is a serious lack of specific details in the various steps of the operation." These authors have investigated the chemical changes taking place in the souring of milk and the relation of these changes to cottage cheese, and from the results of their investigations, which are technical in character, they have elaborated methods for the manufacture of cottage cheese which are described as follows:

(1) **Material to use.**—Skim milk should be used. While whole milk can be used, so much fat is lost that there is serious waste of this valuable constituent.

(2) **Preparation of "starter."**—In manufacturing cottage cheese on a large scale, saving of time is usually effected by using a starter to hasten the souring of the milk. The character of the starter used is of much importance. Ferments other than acid-forming may be present in a starter and cause the formation of a slimy curd from which the whey can not be separated. It is essential, therefore, when one uses a starter, to give some attention to its preparation. The following is suggested as a method that will give good results, if properly carried out: Separator skim milk, prepared from clean, fresh milk is put into a carefully cleaned receptacle, well covered and brought to a temperature of 90° F. (32° C.), after which it is placed where it will remain at a temperature of 65° F. to 70° F. (18° C. to 21° C.). In 20 to 24 hours, the skim milk will be found properly ripened. In using this prepared starter, the upper portion to the depth of 1 or 2 inches is removed and thrown away, the rest is strained through a fine strainer or hair sieve into the milk and thoroughly mixed. Some of this prepared starter may be used in preparing a starter for the day following, putting a little into some skim milk that has been heated to 180° F. (82° C.) for thirty minutes and then cooled to 70° F. (21° C.) and allowed to stand 24 hours. The starter may thus be propagated from day to day. As soon as any unfavorable effect is noticed in curdling, a new starter should be prepared.

[a] Compiled from New York State Sta. Bul. 245.

There are on the market several different preparations for souring or ripening milk and cream, consisting of special cultures. Full directions for methods of use always accompany these special starters and we do not need to consider them here.

(3) **Manufacture of cottage cheese by ordinary souring of milk.**—The milk is kept at a temperature of 70° F. to 75° F. (21° C. to 24° C.) until it is well curdled, which will usually require 24 to 48 hours. The curdled mass is then broken up by hand or cut by a curd knife and is heated gradually to 90° F. (32° C.) and is kept at this temperature until the whey appears clear. When the heat is so applied as to require 30 or 40 minutes to reach 90° F. (32° C.), then the whey will separate clear in 15 or 20 minutes under normal conditions. The whey is then run from the curd and the curd is put into muslin bags or placed on racks and allowed to drain until whey ceases to come from the curd. The curd is then salted at the rate of about 1 pound of salt for 100 pounds of curd, or to taste, shaped into balls, and finally wrapped in oiled paper that may be obtained from any dairy-supply house. For the finest quality of cheese the curd should be mixed with thick cream, preferably ripened cream, at the rate of 1 ounce of cream for 1 pound of cheese, before being made into balls.

(4) **Manufacture of cottage cheese when a starter is used.**—The starter, prepared as described above, or by some equally good method, is added to the milk at the rate of 2 to 3 pounds to 100 pounds of milk and thoroughly mixed through the mass of milk. The rest of the operation is completed as described above under (3).

(5) **Manufacture of cottage cheese when rennet is used, together with starter.**—The starter is added to the milk as described above, and about eight hours later rennet extract is added at the rate of about 1 ounce for 1,000 pounds of milk. The rest of the operation is completed as described under (3) above.

(6) **Manufacture of cottage cheese by direct addition of hydrochloric acid.**—The milk should be at a temperature between 70° F. and 80° F. (21° C. and 27° C.). Measure out hydrochloric acid, of specific gravity 1.20, at the rate of 10 ounces for 100 pounds of milk; dilute this with ten times its bulk of water and add to the milk gradually, stirring the milk constantly while the acid is being added. The stirring is continued until the curd separates fully, leaving a clear whey entirely free from milkiness. As soon as this is accomplished the whey is run from the curd and the rest of the operation completed as described under (3) above. Some care should be exercised in regard to the quality of the hydrochloric acid used. The kind usually kept at drug stores is not pure enough. [Chemically pure hydrochloric acid should be obtained from a reliable dealer in chemicals.]

A CHEAP FRUIT EVAPORATOR.[a]

The desirability of a cheap, effective evaporator for utilizing inferior grades of orchard fruit has been felt by farmers and fruit men in all of our orchard-growing sections. A drying house of this sort enables the grower to utilize fruit that would otherwise go to waste. It supplies a means of caring for surplus fruit in years of superabundant crops, thus keeping up the price of the fruit that is barreled and carrying the surplus over to years of scarcity. In case also of bitter rot the diseased fruit may be used up before it spoils and contaminates surrounding fruit.

An evaporator, simple in design and construction and suited for practical purposes (figs. 6, 7, and 8), is described in a recent publication of

[a]Compiled from Missouri Sta. Circ. 14.

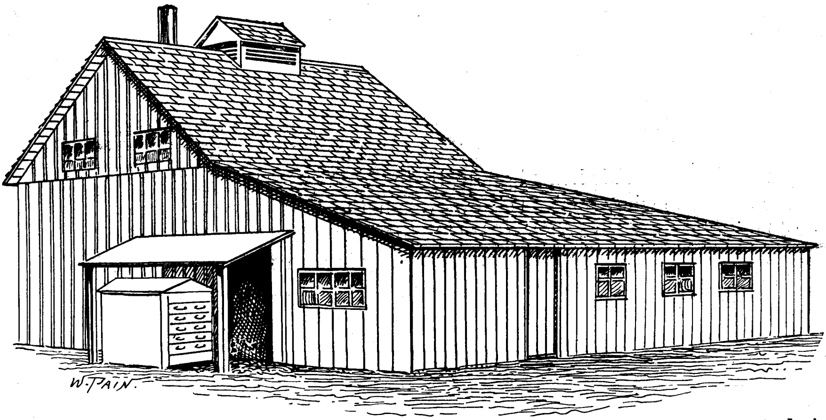

FIG. 6.—Front elevation of fruit evaporator, showing paring shed, bleacher, and entrance to drying room.

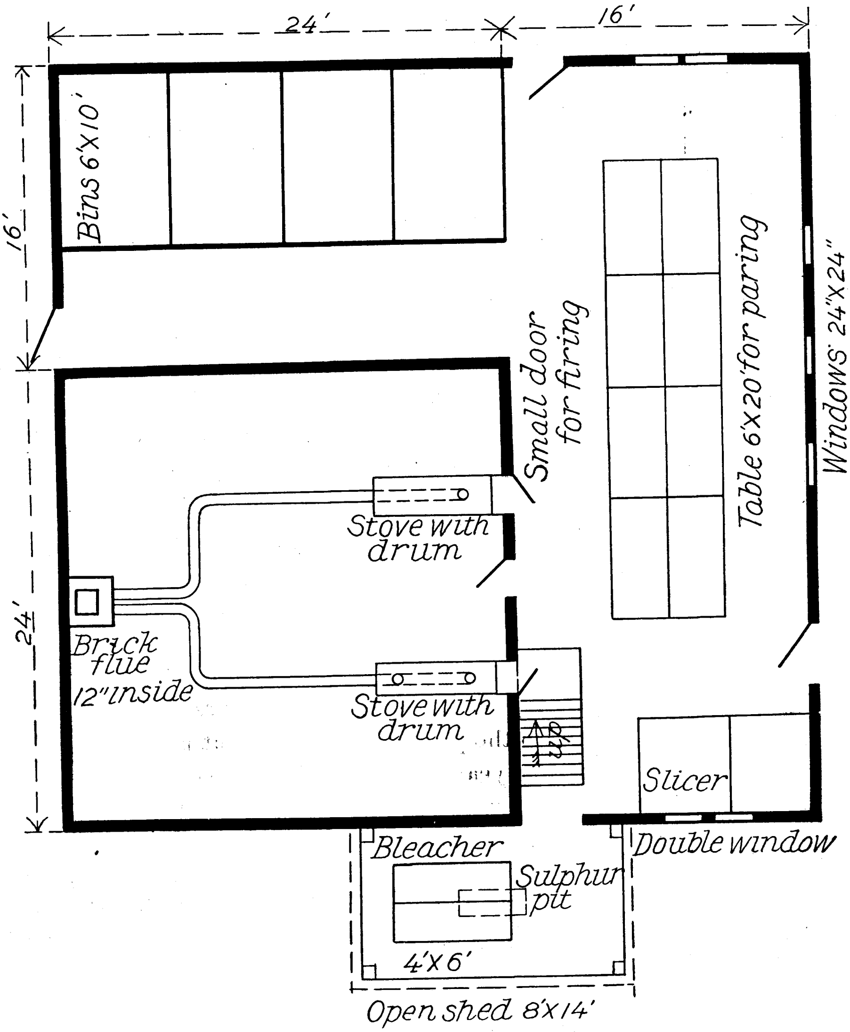

FIG. 7.—Floor plan of fruit evaporator.

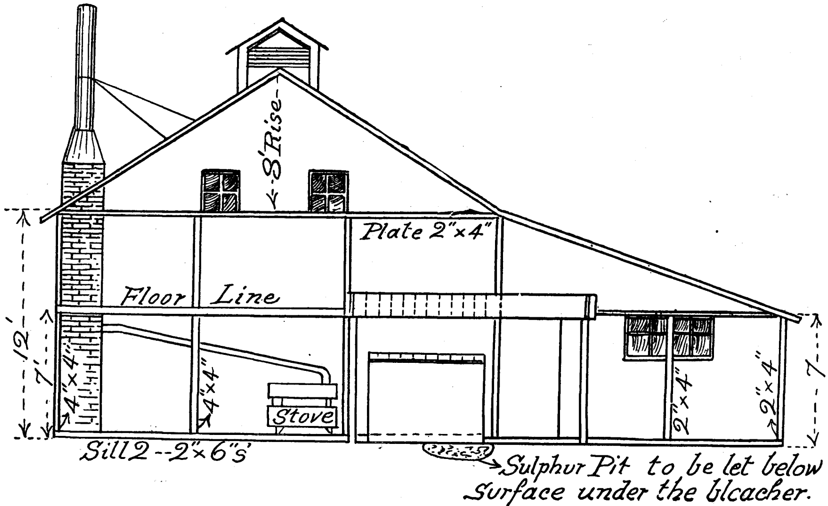

FIG. 8.—Section of fruit evaporator.

the Missouri Station by L. A. Goodman, who has had wide experience in apple growing and in evaporating. Mr. Goodman states that—

All that is required is a plain frame building made of boxing well battened; a slatted upper floor, about 6 feet above the ground for the fruit, and a stove on the lower floor. Almost any old, plain building may easily be converted into an evaporator, and cheap, rough sheds may be built for the fruit and paring machines. This is all that is needed except the bleacher. The building should be about 24 by 24 feet, and 12 feet to the eaves, and will require no bottom floor. It should be made of good, dry, 1 by 12 inch boxing, 12 feet long, and securely battened. The floor joists should be placed about 6 feet above the ground, and be 2 by 6 inches and 12 feet long, resting upon a support in the center of the building. (A building 12 by 12 feet, or 16 by 16 feet, would be large enough for most farmers or fruit men.)

The upper floor should be made of slats 1 inch square and beveled to prevent the fruit from clogging (fig. 9). These are nailed to the

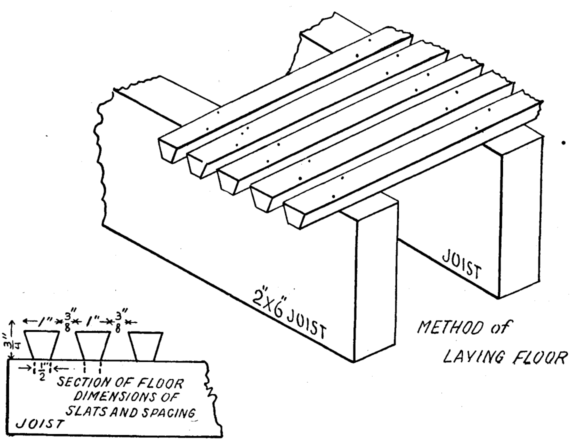

FIG. 9.—Method of laying floor of fruit evaporator.

joists, $\frac{3}{8}$ to $\frac{1}{2}$ inch apart, to allow the hot air to pass up through the fruit which is spread on this floor. The whole space on this floor should be used for drying. Entrance to the room is by stairs on the outside. One or two ventilators in the ridge of the roof will be necessary to carry off the moist hot air. Two large stoves with large drums and plenty of pipe on the ground floor will answer for the furnace, and if the drying room is but 12 by 12 feet or 16 by 16 feet, one stove will be sufficient. The stoves should be so arranged that they may be fired from the outside. Fruit bins and paring tables are arranged in a lean-to shed against the main building, as indicated in fig. 7.

The bins for the apples are always so as to be filled from the outside, and the fruit removed from the inside through the sliding doors. This fruit is carried in baskets or boxes and placed upon the tables where the paring is done, and as fast as pared, should be placed in boxes to be put upon the slicing machine. After slicing they are dropped into trays made 3 by 3 feet of galvanized wire and at once put into the bleaching house where the fumes of sulphur soon bleach the bruised and discolored parts to a pure white. Care must be exercised not to leave the fruit in the bleacher too long or the flavor will be seriously affected. When properly bleached, none of the fruit flavor or quality is lost, which is always the case when bleaching is done after evaporation. The bleacher can be made to hold two sets of trays, end to end, and an opening made so that they can be taken out at each end, but it is much preferable to have an iron hook so as to draw them all out at the point nearest to the stairway leading to the drying room. As soon as bleached the trays of fruit should be carried immediately to the drying room and emptied on the floor. Only a few minutes are needed for the bleaching, so that the trays can be kept in use all of the time by the slicing machine.

This prepared fruit must be put in as rapidly as possible on one side of the drying room so that it will all come out at once when ready for packing into boxes, otherwise a loss of heat and space will result. The same packing tables and the same help that do the paring of the apples may be used for packing the evaporated fruit. The boxes are lined with white paper and then two layers of the best rings are selected and put in the top of the box (the bottom when packing), and then the rest filled in carefully, rejecting anything too soft or too hard to make good fruit. The box is packed tightly and is ready for market.

When the evaporator is not in use for the fruit itself it can be used to evaporate the skins and cores, which will often sell for enough to pay the expense of evaporating the apples. Care will have to be exercised if this is done to wash everything clean before using again for the fruit. Hence it is always best to keep a part of the dry room separated from the rest for this purpose alone and use it for nothing else.

Wood is believed to be the best fuel to use, and a large box stove is recommended. Care must be taken to keep the pipes clean. The building material required for an evaporator 40 by 40 feet, with the necessary paring shed, is estimated by Mr. Goodman to be as follows:

Sills, 2 by 6, 16 pieces, 192 feet B. M.; posts, 4 by 4, 12 pieces, 192 feet B. M.; joists, 2 by 8, 28 pieces, 448 feet B. M.; plates, 2 by 4, 12 pieces, 96 feet B. M.; rafters, 2 by 4, 675 feet B. M.; sheeting, 1 by 6, rough, 1,100 feet B. M.; siding for main part, 1 by 12, 96 pieces, 1,300 feet B. M.; siding for shed, 400 feet B. M.; bins, 400 feet B. M.; floor material, strips 1 by 1 inch, dressed and beveled as shown in fig. 9; shingles, 12,000; glass, 44 panes 12 by 14 inches, for glazing 11 windows 24 by 28 inches.

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